EXECUTIVE SUMMARY

Background and Applicable Standards

Laurel Fork was first listed as impaired in 1994. A 2.84-mile segment of Laurel Fork was listed again on the *1996 303(d) TMDL Priority List* for violations of the fecal coliform bacteria standard and the General Standard (benthic) (VADEQ and VADCR, 1996). The *1998 303(d) Total Maximum Daily Load Priority List and Report* lists Laurel Fork for dissolved oxygen (DO) standard violations as well as for violations of the fecal coliform bacteria standard and the General Standard (benthic, sediment) (VADEQ, 1998). Laurel Fork continued to be listed on the *2002 303(d) Report on Impaired Waters* and on the *2004 Virginia Water Quality Assessment 305(b)/303(d) Integrated Report* (VADEQ, 2004). In 2004, an additional 0.07-mile segment of Laurel Fork was included in the report. The impaired stream segment was updated again for the 2006 assessment. Data collected from station 9-LRR005.59 during a Total Maximum Daily Load (TMDL) special monitoring study showed violations of the bacteria standard and so the TMDL impairment reach was extended upstream to Curran Branch at river mile 5.90. The impaired segment extends from river mile 5.90 downstream to the Virginia-West Virginia state line at river mile 1.35 for a total of 4.55 miles.

TMDL Endpoint and Water Quality Assessment

Fecal Coliform

Potential sources of fecal coliform include both point source and nonpoint source (NPS) contributions. Nonpoint sources include: wildlife, grazing livestock, land application of manure, land application of biosolids, urban/suburban runoff, failed and malfunctioning septic systems, and uncontrolled discharges (straight pipes). Three permitted point sources are associated with the Laurel Fork watershed through the Virginia Pollutant Discharge Elimination System (VPDES). All of these facilities are permitted for fecal control, with design discharges ranging from <0.001-0.50 MGD.

Fecal bacteria TMDLs in the Commonwealth of Virginia are developed using the *E. coli* standard. For this TMDL development, the in-stream *E. coli* target was a geometric

mean not exceeding 126-cfu/100 mL and a single sample maximum of 235-cfu/100 mL. A translator developed by VADEQ was used to convert fecal coliform values to *E. coli* values.

General Standard (benthic) - Sediment

A TMDL must be developed for a specific pollutant(s). Benthic assessments are very good at determining if a particular stream segment is impaired or not, but generally do not provide enough information to determine the cause(s) of the impairment. The process outlined in the Stressor Identification Guidance Document (EPA, 2000) was used to identify stressors affecting Laurel Fork. Chemical and physical monitoring data from VADEQ monitoring stations provided evidence to support or eliminate potential stressors. The potential stressors are: sediment, toxics, low dissolved oxygen, nutrients, pH, metals, conductivity/total dissolved solids, temperature, and organic matter.

The results of the stressor analysis for Laurel Fork are divided into three categories:

> **Non-Stressor(s)**: Those stressors with data indicating normal conditions, without water quality standard violations, or without the observable impacts usually associated with a specific stressor, were eliminated as possible stressors.
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> **Possible Stressor(s)**: Those stressors with data indicating possible links, but inconclusive data, were considered to be possible stressors.
>
> **Most Probable Stressor(s)**: The stressor(s) with the most consistent information linking it with the poorer benthic and habitat metrics was considered to be the most probable stressor(s).

The results indicate that sediment is the Most Probable Stressor for Laurel Fork and were used to develop the benthic TMDL.

Sediment is delivered to Laurel Fork through surface runoff, streambank erosion, and natural erosive processes. During runoff events, sediment is transported to streams from land areas. Rainfall energy, soil cover, soil characteristics, topography, and land management affect the magnitude of sediment loading. Land disturbances from mining, forest harvesting, and construction accelerate erosion at varying degrees. Sediment transport is a natural and continual process that is often accelerated by human activity. An increase in impervious land without appropriate stormwater control increases runoff

volume and peaks, which leads to greater potential for channel erosion. During dry periods, sediment from air or traffic builds up on impervious areas and is transported to streams during runoff events. Fine sediments are included in total suspended solids (TSS) loads that are permitted for wastewater, industrial stormwater, and construction stormwater discharge.

Dissolved Oxygen

Potential sources affecting in-stream dissolved oxygen concentrations include both point source and nonpoint source (NPS) contributions. Potential point sources include wastewater treatment plants, industrial facilities, combined sewer overflows, sanitary sewer overflows, and stormwater runoff. Potential nonpoint sources include erosion of sediments, grazing livestock, land application of fertilizers and manure, land application of biosolids, urban/suburban runoff, failed and malfunctioning septic systems, and uncontrolled discharges (straight pipes).

The source of the low dissolved oxygen in Laurel Fork was determined to be non-regulated sewage discharges, exfiltration and overflows from the Pocahontas Sewage Treatment Plant and collection system, as well as uncontrolled discharges (straight pipes).

Modeling Procedure

Hydrology

The US Geological Survey (USGS) Hydrologic Simulation Program - Fortran (HSPF) water quality model was selected as the modeling framework to model hydrology and fecal coliform loads.

For purposes of modeling watershed inputs to streamflow and in-stream fecal bacteria, the Laurel Fork drainage area was divided into five subwatersheds. A paired watershed approach was utilized to calibrate the hydrology of Laurel Fork. Sand Run in Upshur County, West Virginia (USGS Station #03052500) was selected as the paired watershed based on comparative hydrologic characteristics. The representative time period used for hydrologic calibration of Laurel Fork covered the period 10/1/1992 through 9/30/1997.

Hydrology validation was not performed for Laurel Fork because there were only six measurements of flow collected during the representative modeling period. All observed data collected during this time period was used for hydrology calibration. It was determined that using all available data for calibration would result in a more accurate model.

Fecal Coliform

The fecal coliform calibration for Laurel Fork was conducted using monitored data collected at VADEQ monitoring station 9-LLR001.39. The five years with the most fecal coliform data (23 samples) were used as the calibration time period, 10/1/1994 through 9/30/1999. The fecal coliform validation for Laurel Fork was conducted using monitored data collected at VADEQ monitoring station 9-LLR001.39. For fecal coliform validation, the period selected was 10/1/1990 through 9/30/1994, during which 13 samples were collected. Modeled fecal coliform levels matched observed levels indicating that the model was well calibrated.

The allocation precipitation time period was selected to coincide with the hydrologic calibration time period. The allocation/calibration time period was selected as the years with the most representative rainfall compared to all historic data. The time period used for allocation was 10/1/1992 through 9/30/1997. Modeling during the representative period provided the highest confidence in allocation results.

Sediment

There are no existing in-stream criteria for sediment in Virginia; therefore, a reference watershed approach was used to define allowable TMDL loading rates in the Laurel Fork watershed. The South Fork Powell River watershed was selected as the TMDL reference for Laurel Fork due to the similarity of the watershed characteristics. The TMDL sediment loads were defined as the modeled sediment load for existing conditions from the non-impaired South Fork Powell River watershed and area-adjusted to the Laurel Fork watershed. The Generalized Watershed Loading Function (GWLF) model (Haith et al., 1992) was used for comparative modeling between Laurel Fork and South Fork Powell River.

Existing Conditions

Fecal Coliform

Wildlife populations, the rate of failure of septic systems, domestic pet populations, and numbers of livestock in the Laurel Fork watershed are examples of land-based nonpoint sources used to calculate fecal coliform loads. Also represented in the model were direct nonpoint sources of uncontrolled discharges, direct deposition by wildlife, and direct deposition by livestock. Contributions from all of these sources were updated to 2005 conditions to establish existing conditions for the watershed. The HSPF model provided a comparable match to the VADEQ monitoring data, with output from the model indicating violations of both the instantaneous and geometric mean standards throughout the Laurel Fork watershed.

Sediment

The sediment TMDL goal for Laurel Fork was defined by the average annual sediment load in metric tons per year (Mg/yr) from the area-adjusted South Fork Powell River. The existing conditions were calculated for Laurel Fork. The future conditions were 20.73 Mg/yr greater than the existing conditions; therefore, the sediment loads for future growth conditions was used to determine the sediment TMDL.

The sediment TMDL is composed of three components: waste load allocations (WLA) from permitted point sources, the load allocation (LA) from nonpoint/non-permitted sources, and a margin of safety (MOS), which was set to 10% for this study. The target sediment load was 1,851 Mg/yr. The future load from Laurel Fork was 2,799 Mg/yr.

Load Allocation Scenarios

Fecal Coliform

The next step in the bacteria TMDL process was to reduce the various source loads to levels that would result in attainment of the water quality standards. Because Virginia's *E. coli* standard does not permit any exceedances of the standard, modeling was conducted for a target value of 0% exceedance of the geometric mean standard and 0% exceedance of the single sample maximum *E. coli* standard. Scenarios were evaluated to

predict the effects of different combinations of source reductions on final in-stream water quality.

Laurel Fork requires:

- 36% reductions in direct wildlife loads,
- 86% reductions in NPS wildlife loads
- 70% reductions in direct livestock loads,
- 99% reductions in NPS loads from agricultural and urban/residential areas, and
- 100% reductions in loads from straight pipes.

Table ES.1 Average annual *E. coli* loads (cfu/year) modeled after allocation in the Laurel Fork watershed at the outlet.

Impairment	WLA (cfu/year)	LA (cfu/year)	MOS	TMDL (cfu/year)
Laurel Fork	8.72E+11	1.81E+12	*Implicit*	2.69E+12
VA0091588	*8.71E+11*			
VAG400522	*8.71E+08*			

Sediment

The next step in the sediment TMDL process was to reduce the various source loads to result in average annual sediment load less than the target sediment load. Scenarios were evaluated to predict the effects of different combinations of source reductions on final in-stream water quality. Allocations were developed at the outlet of Laurel Fork.

The final load allocation scenario for Laurel Fork requires a 33.7% overall reduction in sediment loads to the stream. Sediment loads from straight pipes need to be reduced 100% due to health implications and the requirements of the fecal bacteria TMDL. The final TMDL required similar reductions to sediment loads from abandoned mine land (41%), disturbed forest (41%), pasture (38%), high tillage row crops (38%), and streambank erosion (27%). No reductions to TSS permitted sources were required.

Table ES.2 Average annual sediment loads (metric tons per year) modeled after allocation in the Laurel Fork watershed at the outlet.

Impairment	WLA (Mg/yr)	LA (Mg/yr)	MOS (Mg/yr)	TMDL (Mg/yr)
Laurel Fork	21	1,830	206	2,057

Dissolved Oxygen

The intention of this Dissolved Oxygen TMDL (Table ES.3) is to eliminate discharges of raw sewage to the stream. Consequently, the WLA, LA, and TMDL are all zero. The implicit MOS is based on reductions of organic matter delivered to the stream that are anticipated as a result of implementing the sediment TMDL.

Table ES.3 Average annual loads of raw sewage (kg/year) allocated to Laurel Fork.

Impairment	WLA[1]	LA	MOS	TMDL
Total	0	0	*Implicit*	0

[1]The only point source permitted in the drainage with a history of overflow problems is the Pocahontas STP (VPDES # VA0029602).

Implementation

The goal of the TMDL program is to establish a three-step path that will lead to attainment of water quality standards. The first step in the process is to develop TMDLs that will result in meeting water quality standards. This report represents the culmination of that effort for the fecal coliform, benthic and dissolved oxygen impairment on Laurel Fork. The second step is to develop a TMDL implementation plan (IP). The final step is to implement the TMDL IP and to monitor stream water quality to determine if water quality standards are being attained.

To address the bacteria and dissolved oxygen TMDLs, reducing the human waste loading from straight pipes and failing septic systems should be a primary implementation focus because of the health implications. This component could be implemented through education on septic tank pump-outs as well as a septic system installation/repair program. Livestock exclusion from streams has been shown to be very effective in lowering bacteria concentrations in streams, both by reducing the direct cattle deposits and by providing additional riparian buffers.

To address the sediment TMDL, it is anticipated that reclamation of abandoned mine land (AML), and the correction of straight pipes will be initial targets of implementation. Erosion and sediment deposition from disturbed land generally abate over time as new growth emerges. One practice that has been successful on some sites involves regrading and vegetating disturbed areas, and constructing diversion ditches to direct water away from the disturbed area.

There is a measure of uncertainty associated with the final allocation development process. Monitoring performed upon completion of specific implementation milestones can provide insight into the effectiveness of implementation strategies, the need for amending the plan, and/or progress toward the eventual removal of the impairments from the 303(d) list.

Public Participation

During development of the TMDLs for Laurel Fork, public involvement was encouraged through two public meetings and one government kickoff meeting. An introduction of the agencies involved, an overview of the TMDL process, and the specific approach to developing the Laurel Fork TMDLs were presented at the first of the public meetings. Details of the pollutant sources and stressor identification were also presented at this meeting. Public understanding of, and involvement in, the TMDL process was encouraged. Input from this meeting was utilized in the development of the TMDL and improved confidence in the allocation scenarios. The final model simulations and the TMDL load allocations were presented during the final public meeting. There was a 30-day public comment period after the final public meeting and no written comments were received. Watershed stakeholders will have the opportunity to participate in the development of the TMDL IP.

11. WATER QUALITY ASSESSMENT AND TMDL ALLOCATION FOR THE DISSOLVED OXYGEN IMPAIRMENT

11.1 Applicable Criteria for Dissolved Oxygen Impairments

Virginia state law 9VAC25-260-50 defines the numerical criteria for dissolved oxygen in mountainous zones waters as a minimum of 4.0 mg/L and a daily average of 5.0 mg/L. These criteria were used in initially listing Laurel Fork on the 1998 *303(d) Total Maximum Daily Load Priority List and Report* for violations of DO. Laurel Fork remained on the 2002 *303(d) Report on Impaired Waters* and the 2004 *305(b)/303(d) Water Quality Assessment Integrated Report* for violations of the DO water quality standard.

11.2 Assessment of the Dissolved Oxygen Violations

Tables 6.8 through 6.17 and section 7.4.2 provide a detailed summary of the DO concentrations measured at the seven monitoring stations on Laurel Fork. Fifteen of the 61 DO concentrations measured at monitoring station 9-LRR001.39 were below the VADEQ minimum WQS. Upstream monitoring stations 9-LRR004.03 and 9-LRR006.43 each had one violation of the DO standard.

Low DO in a free-flowing stream may be associated with excessive nutrients and high BOD loads. Total phosphorus values measured at station 9-LRR001.39 are not elevated and therefore not likely responsible for low DO in Laurel Fork. The high nitrate-nitrogen concentrations are considered to be from organic compounds (section 7.3.2). Also, from section 7.3.1, the parameters that are indicative of high organic matter reveal that it is elevated in Laurel Fork. Therefore, low DO levels observed in Laurel Fork are most likely due to a high content of organic matter.

Less than 3% of the Laurel Fork watershed is agriculture and there is a small population of livestock (section 3.3.3), therefore it is not likely that livestock is a significant contributor of organic matter to the stream. The Pocahontas STP has a history of operational problems and violations of their discharge limits. Also, comments from attendees at the first public meeting and conversation with the local VDH officials

indicated that there are a high number of uncontrolled discharges and failing septic systems within the Laurel Fork watershed. Human sewage is the likely source of organic matter in Laurel Fork.

The fourteen low DO concentrations measured before June 1999 at station 9-LRR001.39, 0.69 miles downstream from the Pocahontas STP, have been attributed to sewer collection system failure and improper maintenance and operation of the Pocahontas STP (section 6.4.3). VADEQ reports that the problems found in the inspections at the STP were corrected and it has been in compliance with its VPDES permit limits over the past several years.

The most recent measurement of low DO at station 9-LRR001.39 occurred on August 5, 2003. The violation of the DO standard at the upstream monitoring station 9-LRR006.43, near the Boissevain sewer collection pump station, also occurred on the same date. Bacteria counts were extremely high on this date. The fecal coliform enumeration from the water sample collected at station 9-LRR001.39 on August 5, 2003 was 56,000 cfu/100mL; the *E. coli* enumeration was 39,000 cfu/100mL. BST results from the water sample collected this day showed that 88% of the isolates classified as human source (Table 2.3).

While no overflows of the sewer collection system were reported for this day, overflows have been reported throughout the Pocahontas collection system since the correction of the Pocahontas STP (Table 11.1). VADEQ recognizes that not all overflows are necessarily reported. The high bacteria concentrations along with the BST results indicating a highly significant contribution from human source suggests that a large amount of human sewage, possibly associated with an overflow within the sewer collection system, is the most likely cause of the DO violations at the two monitoring stations. Corrections to the sewer collection system and elimination of non-regulated discharges will insure that bacteria concentrations remain below WQS and that DO levels will be above the standard.

Table 11.1 Pocahontas Overflow Summary for April 2002 – January 2005.

Date	Location	Total Gallons	Cause
1/14/2005	Boissevain Pump Station	Unknown	Grease Blockage
7/21/2004	Interceptor above STP	Unknown	Unknown
11/19/2004	Main Pump Station	Unknown	Flooding
2/24/2003	Main Pump Station	Unknown	Flooding
2/18/2003	Main Pump Station	Unknown	Dry well flooded-Pumping out
11/13/2002	Main Pump Station	Unknown	Flooding
5/2/2002	Main Pump Station	Unknown	Flooding

The violation of the DO standard at monitoring station 9-LRR004.03 occurred on November 4, 2003. Nutrient concentrations were not measured at this station, but total phosphorus measurements at station 9-LRR001.39 have consistently been very low (average = 0.09 mg/L). The fecal coliform and *E. coli* concentrations measured at station 9-LRR004.03 on November 4, 2003 were above the maximum detection levels. The source of the high bacteria concentrations is considered to be exfiltration and overflows from the Pocahontas sewer system in addition to non-regulated sewage discharges. The presence of high bacteria concentrations at station9-LRR004.03 is an indicator of a high content of organic matter in the stream.

11.3 TMDL Allocation for the Dissolved Oxygen Impairment

The objective of a TMDL is to provide an allocated load from a pollutant source(s) to meet the WQS. Dissolved oxygen itself is not a pollutant source and from section 11.2 it has been determined that the pollutant source affecting the DO levels in Laurel Fork is the high content of organic matter from human waste. In order to correct the DO impairment, all discharges of raw sewage to the stream should be eliminated. The fecal bacteria TMDL that was developed for Laurel Fork (Table 5.3) requires a 100% reduction of all non-permitted direct sources of human bacteria (*i.e.,* straight pipes, failing septic systems, sewage overflows, exfiltration) deposited to Laurel Fork. These reductions are consistent with the reductions needed to correct the DO impairment.

While the organic solids that enter Laurel Fork through runoff are not as predominant as the organic matter entering the stream directly through non-regulated discharges, the sediment TMDL that was developed for Laurel Fork (Table 10.3) will reduce the sources

of organic matter entering the stream through runoff and therefore contribute to keeping the DO level in Laurel Fork above the WQS. These reductions will provide an implicit margin of safety (MOS) for the DO TMDL.

Table 11.2 describes the allocation of raw sewage to Laurel Fork that is necessary in order to meet the DO standard. The TMDL includes three components – WLA, LA, and the MOS. The intention of this TMDL is to eliminate discharges of raw sewage to the stream. Consequently, the WLA, LA, and TMDL are all zero. The implicit MOS is based on reductions of organic matter delivered to the stream that are anticipated as a result of implementing the sediment TMDL.

Table 11.2 Average annual loads of raw sewage (kg/year) allocated to Laurel Fork.

Impairment	WLA[1]	LA	MOS	TMDL
Total	0	0	*Implicit*	0

[1]The only point source permitted in the drainage with a history of overflow problems is the Pocahontas STP (VPDES # VA0029602).